DESIGN REPORT
FOR THE
STREAMBANK STABILIZATION
OF PETERSON DITCH
LAKE WINONA

PREPARED FOR:

WINONA LAKE PRESERVATION ASSOCIATION
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PREPARED BY:

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EXECUTIVE SUMMARY

Winona Lake is located in Kosciusko County, Indiana adjacent to the Town of Warsaw and the community of Winona Lake. The Winona Lake watershed consists of 18,730 acres of agricultural, forest, and urban land areas. The majority of the drainage enters the Lake through three streams: Wyland Ditch, Keefer-Evans Ditch, and Peterson Ditch. Peterson Ditch enters Winona Lake on the south side of the Lake and has a watershed of 7,026 acres.

A design project was authorized for a portion of Peterson Ditch. Consistent with concerns expressed by the Winona Lake Preservation Association, the design project has focused on implementation of stabilization methods which employ bioengineering treatments. The objective of this design study is to provide the information necessary to construct streambank revetments and implement other protective streambank cover practices which will be effective in reducing the incidence of streambank erosion problems. The design study area involves in excess of 9,000 feet of the channel length from the mouth at Winona Lake to a point approximately 2,000 feet south of the intersection of Co. Rd. 225 S & Packerton Road. This section of Peterson Ditch has extensive bank erosion, dead falls, and mid-channel bars. An extensive survey was performed to accurately depict the profile and cross-sections of the study area.

The design of the stabilization project involves the discreet implementation of various streambank treatments while not significantly modifying the hydraulics of the channel. It is critical to maintain the normal flow rate of the ditch as higher flow rates would serve to further endanger the stabilization of the banks. This study includes typical design details of treatments to be implemented at specific points along the channel. Treatments for implementation include:

Live Stake Installation

Post Revetment with Wire Fencing

Rip-Rap Slope

Rip-Rap & Geocell Slope

Vegetated Rock Gabion

Live Cribwall

These and other treatments are specified on the design plans for individual areas of the stream requiring stabilization. All components of the design project are to meet the technical guidelines set forth by the Lake and River Enhancement Program. We anticipate approval for construction will be granted by the Indiana Department of Natural Resources-Division of Soil Conservation. No additional easements are anticipated.

The design package includes maps, diagrams, and other work products necessary to contract the construction of stabilization measures outlined in this design. Donan Engineering Co., Inc. will act as the agent of the Winona Lake Preservation Association in securing necessary permits required to perform the project.

The estimated cost for construction of the structures and associated items is $83,760.00. The total estimated cost of this project, including construction and construction observation costs, is $92,760.00.

1.0 INTRODUCTION

Winona Lake is located in Kosciusko County, Indiana adjacent to the Town of Warsaw and the community of Winona Lake. The Lake has a surface area of 562 acres. The shores of the Lake are heavily developed with single family residences and condominiums. The Winona Lake watershed consists of 18,730 acres of agricultural, forest, and urban land areas. The majority of the drainage enters the Lake through three streams: Wyland Ditch, Keefer-Evans Ditch, and Peterson Ditch. Peterson Ditch enters Winona Lake on the south side of the Lake and has a watershed of 7,026 acres.

A design project has been completed for a portion of Peterson Ditch as previously defined. The project is intended to be a continuance of the feasibility study performed on Winona Lake and reported in July of 1991. Donan Engineering Co. Inc. concurs with the studies recommendation for streambank stabilization of the Ditch. Consistent with concerns expressed by the Winona Lake Preservation Association, the design project has focused on implementation of treatments which employ bioengineering methods and practices.

This Lake Enhancement Program Design Report details the design procedures that were used and the recommendations for the construction observation, operation and maintenance of the structures. Recommendations regarding post-construction monitoring of the lake influent are also presented. This report should be reviewed in conjunction with the Contract Documents of the Peterson Ditch Streambank Stabilization Lake Enhancement Design Project which includes: plan sheets, advertisement for bids, information to bidders, bid and bid bond, agreement, payment bond and performance bond, special conditions, general conditions, and technical specifications.

2.0 GENERAL PROJECT DESCRIPTION

Sediment and nutrient loading have been identified as predominant water quality impairments to Winona Lake. Sediment accumulation at the mouth of Peterson Ditch has been observed for many years. An aerial photo taken during a precipitation event in the spring of 1989 displayed an extensive plume at the outlet of Peterson Ditch (Outdoor Indiana, May, 1989). As stated in the Feasibility Study, Winona Lake was placed in Trophic Class Three in 1986 by the Indiana Dept. of Environmental Management (IDEM). This index value was based on data collected in 1976 and the Lake had an Eutrophication Index (EI) of 56. A recent re-evaluation of this data gives the Lake an EI value of 47. Lakes in this category are described by IDEM as intermediate quality, intermediate level eutrophic lakes which are often productive, but exhibit subtle trophic changes. Other characteristics include oxygen depletion below the thermocline during stratification, algal blooms during the summer months, and extensive macrophyte concentrations in the bays and littoral areas of the Lake. Lakes in this group have the poorest water quality of any lakes in the State. Management priorities of these lakes are to improve water quality as quickly as possible through restoration and nutrient abatement programs.

An evaluation of the three major influent streams, including Peterson Ditch, was conducted in November 1989. The purpose of this evaluation was to analyze streambank stability and classify the stream channel reaches according to the major variables that control channel geomorphology. The three stream systems were classified using a system developed by David l. Rosgen, U.S. Forest Service (Rosgen, 1986). The Rosgen Stream Classification System categorizes stream channels according to gradient, sinuosity, width/depth ration, dominant size of channel materials, valley confinement, and land form features including dominant soils and stability.

The physical features that form the basis of the Rosgen system also provide valuable information on habitat suitability. For each stream classification in the Rosgen system, specific measures have been developed to restore and/or improve fish habitat. The system is also important for predicting the response of a stream channel to altered flow regimes, or changes in sediment supply. Depending on the stream's classification, a reduction in the external sediment loading, such as that which would occur if best management practices were implemented, may or may not result in reduction of in-stream sediment transport. For some streams, the process of recovery from excess sediment supply may take many years, and the stream could continue to supply sediment from the banks themselves long after upland sources have been controlled. For these streams, measures to stabilize the channel and restore the natural pattern of the stream may be necessary in conjunction with upland sediment controls.

According to the feasibility study, Peterson Ditch was classified as a C-3 Channel type using the Rosgen Stream Classification System. C-3 streams usually provide good habitat for fish and aquatic invertebrates. The size of the streambed material is coarse and variable enough to provide a variety of habitat conditions suitable for spawning, feeding, and resting. Due to greater width to depth ratios, these streams may have a shortage of deep water areas during summer low flows. Areas that do not have sufficient depth at low flow can be enhanced with habitat improvement measures such as low profile deflectors or bank imbedded boulders. Both of these measures create pool conditions at low flows. Another characteristic of C-3 streams is that they are easily destabilized by large inputs of suspended sediment. The response to an increase in sediment loading is the formation of in-channel bars and lateral adjustment, i.e. streambank erosion. This process adds even more sediment loading conditions downstream.

Extensive streambank erosion and mid-channel bar formation was found within the lower one and one half miles of this tributary. Until it is stabilized, this section of Peterson Ditch will be a significant source of sediment to Winona Lake. The erosion that is occurring will accelerate as the streambanks supply more sediment to the stream, which is already unable to transport all of the current sediment loading.

3.0 OBJECTIVE OF THE DESIGN

The objective of this design study is to provide the information necessary to construct streambank revetments and implement other protective streambank cover practices which will be effective in reducing the incidence of streambank erosion problems. The design study area involves in excess of 9,000 feet of the channel length from the mouth at Winona Lake to a point approximately 2,000 feet south of the intersection of Co. Rd. 225 S & Packerton Road. This section of Peterson Ditch has extensive bank erosion, dead falls, and mid-channel bars. The design study includes an extensive survey to accurately depict the profile and cross-sections of the study area of the stream. Cross-sections extend from the center of the ditch to points varying from 25 to 75 feet from the top of streambanks as required. The survey provides information as to the stream centerline, location and features of eroding banks, channel path, channel dimensions, slope of the channel, the water surface, and contours of the study area. The survey also is the basis for considerations of realignment of segments of the stream.

The design of the stabilization project involves the discreet implementation of various streambank treatments while not significantly modifying the hydraulics of the channel. It is critical to maintain the normal flow rate of the ditch as higher flow rates would serve to further endanger the stabilization of the banks. This study includes typical design details of treatments to be implemented at specific points along the channel. Treatments for implementation include:

Live Stake Installation

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These and other treatments are specified for areas of the stream requiring stabilization. All components of the design project are to meet the technical guidelines set forth by the Lake and River Enhancement Program. We anticipate approval for construction will be granted by the Indiana Department of Natural Resources-Division of Soil Conservation. No additional easements are anticipated.

The design package includes maps, diagrams, and other work products necessary to contract construction of stabilization measures for the study area of the ditch. Donan Engineering Co., Inc. will act as the agent of the Winona Lake Preservation Association in securing necessary permits required to perform the project.

4.0 SOIL BIOENGINEERING MATERIALS

4.1 Locating and Selecting Plant Materials

Commercially grown plant materials are suitable sources of vegetation for use in soil bioengineering systems. It is critical, however, to allow for adequate lead time for their procurement and delivery. In addition, delays in installation seriously affect survival rates. Correctly selected indigenous species harvested from existing stands of living woody vegetation are the preferred soil bioengineering materials. The use of indigenous live materials requires careful selection, harvesting, handling, and transporting.

Live plant materials can be cut from existing stands found near Peterson Ditch or within practical hauling distance. The source site(s) must contain plant species that will propagate easily from cuttings.. Recommended species include Red Willow, Black Willow, Pussy Willow, Ninebark, Red Osier Dogwood, Silky Dogwood and Buttonbush. Other locally available species which can be propagated by cuttings may also be selected as approved by the Lake & River Enhancement staff of IDNR. Cuttings are to be 1/2 to 2 inches in diameter and will range in length from 2 to 12 feet.

Chain saws, bush axes, loppers, and pruners are recommended for cutting living plant materials. Onsite plant material is to be harvested carefully. Based on arrangements made with the owner of the plant material source site, it may be appropriate to clear cut large areas. In other situations, selective cuttings may be required. In these situations, cuts should be made at a blunt angle, 8 to 10 inches from the ground, to assure that the source sites will regenerate rapidly with healthy vegetation. Remnant materials that are too large for use in soil bioengineering are to be piled for wildlife cover and the site is to be left in a condition that will enhance its potential for regeneration.

Live cuttings are to be bundled together securely at the collection site for easy loading and handling and for protection during transport. Side branches and brushy limbs should be kept intact. Bundles of live cuttings are to be placed on transport vehicles in an orderly fashion to prevent damage and facilitate handling. Loads should be covered during transportation to prevent drying and additional stress. Live cuttings should be delivered to the project site within 8 hours of harvest and should be installed immediately. This is especially critical when the ambient temperature is 50 °F or above. Live cuttings not installed on the day they arrive should be promptly placed in controlled storage conditions and protected until they can be installed. Storage should involve continuous shade, shelter from the wind, and protection from drying by heeling into moist soil or storing in uncontaminated water. All live cuttings must be removed from storage and installed within 2 days of harvest.

4.2 Installing Plant Materials

Installation of live cuttings shall begin concurrently with earthwork to reshape targeted areas of the streambank of Peterson Ditch. Soil bioengineering systems are to be installed in the dormant season; between October and March. Given the cold winters typically occurring in Kosciusko County, October and November are the preferred installation dates.

Onsite topsoil is to be used as the planting medium for the project. Gravel from the ditch is not suitable material for use as fill around live plant materials. Soil bioengineering systems are to be installed in a planting medium that includes fines and organic material and is capable of supporting plant growth. Muddy soils that are otherwise suitable should not be used until they have been dried to a workable moisture content. Heavy clay soil, if encountered, is to be mixed with organic soils to increase porosity. Select soil backfill does not need to be organic topsoil, however it must be able to support plant growth.

Soil samples of the onsite materials are to be taken prior to installation of live woody cuttings. Nutrient testing by an approved laboratory shall include analyses for a full range of nutrients and pH. Laboratory reports are to include recommended fertilizer and lime amendments for woody plant requirements.

All fill soil around the live vegetative cuttings is to be compacted to densities approximating the surrounding natural soil densities. The soil around plants should be free of voids.

5.0 TREATMENTS

5.1 Live Stake Installation

Live staking involves the insertion and tamping of live, rootable vegetative cuttings into the ground. Correctly prepared and placed, the live stake will root and grow. A system of stakes creates a living root mat that stabilizes the soil by reinforcing and binding soil particles together and by extracting excess soil moisture. This method enhances conditions for natural invasion and

and by extracting excess soil moisture. This method enhances conditions for natural invasion and the establishment of other plants from the surrounding plant community. Most willow species root rapidly and begin to dry out a slope soon after installation. This is an appropriate technique for repair of small earth slips and slumps. This method is to be implemented in four areas of Peterson Ditch as detailed in the plans.

Prior to installation, the live stakes need to be properly prepared. The rootable vegetative cuttings are to be from ½ to 1½ inches in diameter and 2 to 3 feet in length. The materials must have branches cleanly removed and the bark is to be intact. Basal ends should be cut at an angle for easy insertion into the soil and tops should be cut square.

Materials should be installed the same day they are prepared. Live stakes are to be driven into the ground perpendicular to the slope. The installation may be started at any point on the slope face though it is generally easier to start at the top and work down the slope. Live stakes should be installed 2 to 3 feet apart using triangular spacing. The density of the installation is to range from 2 to 4 stakes per square yard.

The installer is to be attentive that buds on the stakes are oriented up. Four-fifths of the length of the live stake should be installed into the ground and soil firmly packed around it after installation.

A protective cap may be placed over the top of the stake to protect the stake from splitting and deformation. A dead blow hammer is used to drive the stake into the ground. In firm soil, the installer may use an iron bar to prepare a pilot hole in which to drive the live stake.

5.2 Post Revetment with Wire Fencing

Continuous post revetment with a facing of woven wire is a common type of protection particularly adapted to streams where the depth of water next to the bank is in excess of 3 to 4 feet. This type of protection is easily damaged by ice flows and/or heavy flood debris and should not be used where these problems occur.

Posts are spaced from 6 to 8 feet on centers. Posts should have a diameter sufficiently large to permit driving to the required depth. The posts are driven to a depth of approximately one-half length below the point of maximum scour. In areas where the streambed is firm and not subject to appreciable scour, the posts should be driven to refusal or to a depth of at least one-half the length. The posts are carried to the height required to protect the bank, which is generally the full height of the bank.

A heavy grade of woven wire, which conforms to the specifications, is fastened to the stream side of the post. Its purpose is to collect debris and trash and form a permeable wall which serves to reduce the velocity on the bank side. In areas of the streambed susceptible to scouring, the woven wire is extended horizontally toward the streambed for a distance at least equal to the anticipated depth of scour. Available stones or concrete rubble or blocks are attached to the bottom of the woven wire at regular intervals. Blocks with holes can be attached by running smooth wire through the block holes and then attaching it to the bottom course or strand of the wire fence. For stones or rubble which are solid, these weigths can be secured to the wire fence by wrapping them in cut sections of wire fencing which can then be wired to the bottom strand of the wire fencing. When scouring occurs the weights cause the wire to settle in a vertical position along the face of the posts. Brush and debris are to be placed behind the posts to increase effectiveness. This brush and debris is to be bundled and wired to the driven posts.

5.3 Rip-Rap Slope

In keeping with the preference to use soil bioengineering methodology, rip-rap is being specified to supplement past repair activities which involved rip-rap, or concrete rubble etc. and to protect bridge abutments. Rock rip-rap, properly placed, is one of the most effective methods of streambank protection. For successful ripping, the toe of the revetment must be firmly established. This is especially critical when the stream bottom is unstable or subject to scour during peak flows. The toe trench is to be extended down to a safe grade and backfilled with heavy rock. In addition to providing protection down to the lowest expected stable grade, additional depth must be provided to reach a footing that cannot be scoured out by temporary high velocity flows or lose its stability through saturation.

Banks on which rip-rap is to be placed are to be sloped so that the pressure of the stone is mainly against the bank rather than against the stone in the lower courses and toe. This slope is to be no steeper than 2:1

A filter blanket is to be placed between the rip-rap and the streambank, unless the composition of the material in the streambank to be protected is so graded as to constitute a suitable filter material. The filter is to be a minimum of 6 inches in thickness. Streambed material composed of relatively clean sand and gravel are to be used for the filter material. It should seldom, if ever, be necessary to hand place the stones in a revetment. While the revetment may have a somewhat less "finished" look, it is adequate to mechanically dump the stones and rearrange them with only a minimum of hand labor. However, dumping on a slope must be done in a manner that will not cause separation of the small and large stones. The finished surface must not have pockets of finer materials which would flush out and weaken the revetment. Sufficient hand placing and chinking should be done to provide a keyed surface. In all applications, rip-rap is to extend up the bank to an elevation where vegetation will provide adequate protection.

5.4 Rip-Rap & Geocell Slope

Rip-rap is installed on the slope near and below the waterline as in the previous application with attention given to the stabilization of the toe of the rip-rap. This treatment requires less rip-rap to be transported to the site and is generally more visually appealing. Geocell is to be installed in the interval between the rip-rap and the top of the bank. Soil material, from the streambank, is to be placed in the Geocell followed by the installation of live stakes. These stakes are to be installed in a manner consistent with the methodology and spacing detailed previously.

5.5 Vegetated Rock Gabions

Vegetated gabions begin as rectangular containers fabricated from a triple twisted, hexagonal mesh of heavily galvanized steel wire. Empty gabions are to be placed in position, wired to adjoining gabions, filled with stone and then folded shut and wired at the ends and sides. Live branches are then to be placed on each consecutive layer between the rock-filled baskets. These will take root inside the gabion baskets and in the soil behind the structures. In time the roots consolidate the structure and bind it to the slope.

This application is intended for shallow installations to address sloughing of the streambank or slopes. Live branches of willow or other suitable vegetative material with diameters ranging from 1/2 to 1 inch are to be used. The branches are to be sufficiently long (6 to 12 feet) to reach beyond the back of the gabion into the backfill which is to serve as a root medium.

Starting at the lowest point of the slope, loose material is to be excavated until a stable foundation is reached. The bank or backside of the excavation is to be excavated deeper than the front to allow for the gabion to tilt toward the streambank. This will provide additional stability to the structure and ensure that the living branches root well. The fabricated wire basket is then placed in the bottom of the excavation and filled with rock. Excavated backfill is then placed between and behind the wire baskets.

Live branch cuttings are then to be placed on the gabions perpendicular and diagonal to the slope in crisscross fashion with the growing tips oriented away from the bank and extending beyond the backs of the gabions into the fill material. Soil is placed over the cutting and compacted. This process is repeated until the structure reaches the required height.

5.6 Live Cribwall

A live cribwall consists of a hollow, box-like interlocking arrangement of untreated log or timber members. The structure is filled with suitable backfill material and layers of live branch cuttings which root inside the crib structure and extend into the slope. Once the live cuttings root and become established, the subsequent vegetation gradually takes over the structural functions of the wood members.

This technique is to be used at the base of a slope to provide a low wall to stabilize the toe of the slope and reduce its steepness. It is to be constructed to a maximum of 6 feet in overall height, including the excavation required for a stable foundation. The site targeted for this technique has limited space between the slope and the streambank which is a factor for selecting this particular technique. A live cribwall can be installed where space is limited and a more vertical structure is necessary. Immediate protection is provided from erosion by the structure while vegetation is established. Once established, the vegetation provides long-term stability. The structure should be tilted back or battered toward the slope when installed.

In preparation for installation, live branch cuttings are to be 1/2 to 2 inches in diameter and long enough to reach well behind the back of the wooden crib structure These cuttings will need to range from 6 to 12 feet in length. Logs or timbers are to range from 4 to 6 inches in diameter. Lengths will vary with the size of the structure as defined by the limited space for the construction of the structure. Timbers are to be secured together by rebar.

Beginning at the lowest point of the slope, excavate loose material until a stable foundation is reached. Excavate the back of the stable foundation (closest to the slope) slightly deeper than the front to add stability to the structure. The first course of logs is to be placed at the front and back of the excavated foundation approximately 4 to 5 feet apart and parallel to the slope. The next course of logs or timbers is to be placed at right angles (perpendicular to the slope) on top of the previous course to overhang the front and back of the previous course by 3 to 6 inches. These should also be 4 to 5 feet apart. Each course of the live cribwall is placed in the same manner and pinned together with rebar until the structure reaches a point approximately one foot above the ordinary stream elevation. The structure is then to be backfilled with available stone and gravel from the streambed. This material is to be used to prevent backfill from being scoured out of the structure. The stone and gravel backfill is then to be topped with soil and gravel to serve as a rooting medium for the live cuttings. Live branch cuttings are to be placed on the compacted backfill perpendicular to the slope (using shorter branches), and diagonally across the cribwall in both directions (using longer branches) in such a manner that the leafy end of the branches project out from the face and sides of the cribwall. Approximately 30 branches should be installed per lineal foot of cribwall for each tier. The branches are then covered with soil backfill and compacted. The cribwall construction is to be continued in the following sequence:

1. Placement of timbers parallel to the slope at the front and back of the cribwall 4 to 5 feet apart.
2. Placement of timbers perpendicular to the slope 4 to 5 feet apart.
3. Pinning of courses of timbers together and to the previous course with rebar.
4. Backfilling and compacting the course with excavated material.

5. Placement of live branch cuttings on the fill with tops facing the stream. Branches are to be placed perpendicular and diagonal to the slope in crisscross fashion. Cut ends are to be embedded into the slope whenever possible.
6. Follow each layer of branches with a layer of compacted soil to ensure soil contact with the live branch cuttings.
7. Repeat with the next course.

The maximum height of the cribwall is to be 6 feet measured from the lowest course at the foundation. Once the live cribwall is constructed, excavated fill material is to be placed on top and behind the structure to blend it in with slope. The surface is to be planted with erosion control species and mulched.

6.0 STABILITY ANALYSIS

Resistance of soil to *sheet erosion* has been evaluated in the development of the Universal Soil Loss Equation. A soil's inherent erodibility factor (K) is assigned to a soil type with a higher number indicative of increased susceptibility to sheet erosion. Soils with higher K factors and other contributing factors are categorized as highly erodible lands. It should be noted that this categorization pertains to sheet erosion only. The erodibility factor is *not* to be used to evaluate a soil's erosion resistance to flow in a channel.

Soils resist erosion during channel flow in two ways:

1. Coarse-grained soils, such as sand and gravel, resist movement by the weight of individual particles. Other things being equal, the heavier a particle is, the greater its resistance to movement. Platy, elongated, and low-density particles are moved more easily than equidimensional and denser particles.
2. Fine-grained soils resist erosion as a mass held together by the cohesion between particles.

The erosion resistance of soils can be rated on the basis of a soil's Plasiticity Index (PI) and Unified Soil Classification System. The higher the PI, up to 20, and the more clayey the soil, the greater its erosion resistance. The Unified classification of CL with a PI=20 has greater erosion resistance than a CL with a PI=15. A CL with a PI=15 has greater erosion resistance than an ML with a PI=15. The Soil Survey of Kosciusko County, Indiana identifies the soil along the project area of Peterson Ditch as Shoals loam. Soil surveys provide general information about the soil map units found within a given county. Since the treatments specified in the design are to be applied at various locations along the streambank, the general nature of the information supplied by the soil survey is believed to be adequate. Based on the soil survey, the Shoals loam is classified as CL-ML which is silty clay ranging to CL which is lean clay. These soils have a PI ranging from 5 to 15 but generally are below 10. Soils are rated as to their relative desirability for erosion resistance for use as a material in which to excavate a channel. On a scale of 1 to 10, with 1 being the most desirable, soils classified as CL are rated as a 9 while ML soils are considered unsuitable. Attempts to stabilize eroded sections of the ditch without the implementation of erosion protection practices then, are likely to have limited success.

7.0 ESTABLISHMENT AND MAINTENANCE

7.1 Establishment

Inspections should be made periodically after the soil bioengineering systems and other structures are installed. Installed plant materials are to be inspected for insect and/or disease infestations, moisture stress, damage by severe storms, and other conditions that could lead to poor survivability. Systems should be inspected monthly while vegetation becomes established. Systems not in acceptable growing condition should be noted and, as soon as seasonal conditions permit, should be removed from the streambank and replaced with materials of the same species and sizes as originally specified. Needed re-establishment work should be performed as needed during an initial 2-year establishment period. This will typically consist of replacing dead plant material, specifically the stakes which do not survive after installation.

Rip-rap, fencing, and other inert materials should also be inspected during this period for damage or displacement and repairs should be made immediately. Extra inspections should always be made during periods of drought or heavy rains.

7.2 Maintenance

After inspection and acceptance of the established system, maintenance requirements should be minor under normal conditions. Maintenance generally consists of light pruning and removal of undesirable vegetation. Heavy pruning may be required to reduce competition for light or stimulate new growth in the project plantings. The selective removal of vegetation may be required to eliminate undesirable invading species that should be removed every 3 to 7 years.

More intensive maintenance may be required to repair problem areas created by high intensity storms or other unusual conditions. Site washouts should be repaired immediately. Generally, re-establishment should take place for a 1 year period following construction completion and consists of replacement of dead unrooted plants, soil refilling and compacting, insect and disease control, weed control, replacement of displaced or damaged inert structures. Rills and gullies should be repaired through the use of healthy, live branch cutting during the dormant season or, if the dormant season has passed, the use of rooted stock may be considered.

8.0 PERMITS

The design project involves construction activities in both the floodway of a regulated waterway and within regulated waters of the United States. A Construction in a Floodway permit is required for construction activities in the floodway of a regulated waterway. This permit is issued by the Indiana Department of Natural Resources, Division of Water. Construction activities proposed for waters of the United States are regulated under Section 404 of the Clean Water Act. The U. S. Army Corps of Engineers has the regulatory authority and responsibility to issue permits for those activities. Activities which fall under the jurisdiction of the Corps of Engineers must also be reviewed by the Indiana Department of Environmental Management (IDEM). Upon IDEM's review and subsequent approval, IDEM will need to issue a Water Quality Certification to supplement the Corps of Engineers permit. Permit applications are to be submitted to the three regulatory authorities upon approval of the design project by the Owner and the Lake & River Enhancement Section of the IDNR Division of Soil Conservation.

9.0 CONSTRUCTION OBSERVATION PLAN

The construction observation plan is provided to aid the Construction Engineer in identifying what should be monitored and observed during construction. The construction observation plan will also identify any specified methods, procedures, and equipment which should be used during construction by the Construction Engineer.

The Construction Engineer should not limit the observation to only the items described in this construction observation plan. This plan should be used in conjunction with the Technical Specifications contained in the Contract Documents.

The Construction Engineer (or the Construction Engineer's representative) which observes the construction of this project should have a solid background in streambank stabilization particularly with soil bioengineering methodology. The observer should have an understanding of the installation techniques for all treatments included in the design plan.

The Construction Engineer will be responsible for producing a set of as built plans following the completion of the project as part of the construction observation.

9.1 Live stake Installation

The earthwork shall consist of the work described in the Contract Documents. The Construction Engineer will be responsible for random visual examinations of the live stakes and the installation techniques.

These random examinations, conducted by the Construction Engineer, shall be a check that the Contractor is installing the live stakes as described in the Contract Documents. The examinations shall be completed during the installation of live stakes. The Construction Engineer should make random observations on the location, orientation, and concentration of the live stakes to check compliance of the Contractor with Contract Documents. Continuous monitoring is not required for this item.

The Construction Engineer should have an Engineer's scale and a measuring tape to monitor the installation of live stakes.

9.2 Post Revetment with Wire Fencing

The post revetment with wire fencing shall consist of the work described in the Contract Documents. The Construction Engineer will be responsible for observing the post revetment with wire fencing completed by the Contractor. The Construction Engineer should examine the locations, spacings, depths, and reaches of the posts being installed for wire fencing to check compliance by the Contractor with the Contract Documents. The Construction Engineer will be responsible for random visual examinations of the posts and fencing and the installation techniques. It will not be the responsibility of the Construction Engineer to complete construction layout or grade staking. Post revetment with wire fencing will not require continuous monitoring by the Construction Engineer. The Construction Engineer should have an Engineer's scale and a measuring tape to monitor the installation of live stakes.

9.3 Rip-rap Slope

The rip-rap slope shall consist of the work described in the Contract Documents. The Construction Engineer will be responsible for observing the rip-rap slope construction completed by the Contractor. The Construction Engineer should examine the location, slopes, and reaches of the rip-rap slopes to check compliance by the Contractor with the Contract Documents. It will not be the responsibility of the Construction Engineer to complete construction layout or grade staking. Rip-rap slopes construction will not require continuous monitoring by the Construction Engineer. The Construction Engineer should have a hand level, a scale, and a tape measure to monitor the construction of the rip-rap slopes.

9.4 Rip-rap and Geocell Slope

The rip-rap and geocell slope shall consist of the work described in the Contract Documents. The Construction Engineer will be responsible for observing the rip-rap and geocell slope construction completed by the Contractor. The Construction Engineer should examine the location, slopes, and reaches of the rip-rap and geocell slopes to check compliance by the Contractor with the Contract Documents. It will not be the responsibility of the Construction Engineer to complete construction layout or grade staking. Rip-rap and geocell slopes construction will not require continuous monitoring by the Construction Engineer. The Construction Engineer should have a hand level, a scale, and a tape measure to monitor the construction of the rip-rap & geocell slopes.

9.5 Vegetated Rock Gabions

The vegetated rock gabions shall consist of the work described in the Contract Documents. The Construction Engineer will be responsible for observing the vegetated rock gabions construction completed by the Contractor. The Construction Engineer should examine the location, tilt, height, and reaches of the vegetated rock gabions to check compliance by the Contractor with the Contract Documents. It will not be the responsibility of the Construction Engineer to complete construction layout or grade staking. Vegetated rock gabions will not require continuous monitoring by the Construction Engineer. The Construction Engineer should have a hand level, a scale, and a tape measure to monitor the construction of the vegetated rock gabions. The Construction Engineer shall require that certifications of compliance pertaining to the manufacturing of the geocell be given to him by the Contractor.

9.6 Live Cribwall

The live cribwall shall consist of the work described in the Contract Documents. The Construction Engineer will be responsible for observing the live cribwall construction completed by the Contractor. The Construction Engineer should examine the location, assembly, tilt, height, and reaches of the live cribwall to check compliance by the Contractor with the Contract Documents. It will not be the responsibility of the Construction Engineer to complete construction layout or grade staking. The live cribwall will require continuous monitoring by the Construction Engineer. The Construction Engineer should have a hand level, a scale, and a tape measure to monitor the construction of the live cribwall.

The Construction Engineer will be responsible for observing the placement of these items by the Contractor. The Construction Engineer shall also collect all tickets to verify the quantity of rip-rap, posts, wire fencing, and other materials to be installed to the site by the Contractor.

9.7 Mulched Seeding

This shall include the work described in the Contract Documents for mulched seeding. The Construction Engineer will be responsible to observe the work completed by the Contractor under this item. The Construction Engineer shall also collect seed certifications from the Contractor on the seed used as described in the Contract Documents and shall collect all weigh tickets on seed, mulch, lime, and fertilizer used. Continuous monitoring is not required for mulched seeding, but the Construction Engineer shall observe that the mulched seeding is completed according to the Contract Documents.

10.0 POST-MONITORING PLAN

The intent of the post-monitoring plan is to evaluate the efficiency of the previously described structures in stabilizing the targeted sections of streambank of Peterson Ditch. The plan will describe the type of monitoring, monitoring locations, frequency, and monitoring methods. It will be the responsibility of the Winona Lake Preservation Association to complete the monitoring in accordance with the methods and procedures contained herein. The person, company, corporation, etc. which is directed by the Association to complete the monitoring should be competent in making those observations.

The monitoring shall continue for a period of two (2) years following the completion of the structures. The monitoring shall consist of collecting water samples during storm events, recording storm event rainfall, recording flow through the Ditch, and lake pool elevation. The monitoring should be conducted semi-annually in November (to coincide with pre-construction sampling in November of 1989 as reported in the feasibility study) and in May.

More recent pre-construction monitoring of the existing inlet areas is preferable, but it is not required. This would enable a better estimation of treatment efficiency to be determined by comparison of pre-construction to post-construction data.

All post monitoring data shall be made available by the Winona Lake Preservation Association to the Department of Natural Resources, Division of Soil Conservation for their use.

10.1 Water Sample Collection and Analysis

A water sample shall be taken at both the mouth of Peterson Ditch and at County Road 300 South. Samples are to be collected during a storm event. These samples shall be analyzed for total suspended solids, total phosphorus, nitrates and total kjeldahl nitrogen. The following paragraphs identify the methods that should be used for water sample collection and analysis. The collection and analysis procedures were taken from the Standard Methods for the Examination of Water and Wastewater, 17th Ed. which is endorsed by the American Water Works Association (AWWA), American Public Health Association (APHA), and the Water Pollution Control Federation (WPCF).

10.1.1 Total Suspended Solids

The samples should be collected in 125 ml high density polyethylene (HDPE) bottles. The total suspended solids should be determined as described in 2540 D.

10.1.2 Total Phosphorus

The samples should be collected in 125 ml acid washed glass bottles. The samples should be preserved with 1 ml conc. HCl/L and stored at 4°C as described in 4500-P.A.5. The samples should be digested according to the Sulfuric Acid-Nitric Acid Digestion as described in 4500-P.B.4. After digestion, the samples should be quantified using the Ascorbic Acid Method as described in 4500-P.E.

10.1.3 Nitrates

The sample should be collected in 125 ml high density polyethylene (HDPE) bottles. The sample should be preserved with 2 ml of concentrated H_2SO_4/liter sample if they are to be stored longer than 24 hours. The samples should be stored at 4°C. The nitrates should be analyzed using either the Nitrate Electrode Method - 4500-NO_3-D, or by Ion Chromatograph - 4500-NO_3C.

10.1.4 Total Kjeldahl Nitrogen

The samples should be collected in 125 ml high density polyethylene (HDPE) bottles. The samples should be acidified to a pH of 1.5 to 2.0 with concentrated H_2SO_4 and stored at 4°C as described in 4500-Norg A.2. The samples should be digested and distilled according to the Semi-Micro-Kjeldahl Methods described in 4500-Norg C. The final ammonia determination may be done by nesslerization, manual phenate, titration, or ammonia-selective electrode method as described in 4500-NH_3 C, D, E, and F.

10.1.5 Caution with Acids

Caution should be taken when conducting any of the above listed tests. Several of these tests use toxic and/or corrosive chemicals. Extra care should be exercised when working with H_2SO_4, HCl or HNO_3 as described in the above methods.

10.2 Storm Event Rainfall

The rainfall which occurs during the storm event in which the monitoring is completed should be recorded. This can be accomplished by a rain gauge on site or by contacting an authorized weather monitoring station in the near vicinity of Winona Lake. The rainfall data should be recorded each time the monitoring is completed.

10.3 Flow of Runoff Through the Structures

Flow through Peterson Ditch should be recorded during the collection of the water samples. This can be completed by measuring water widths and depths at the sampling points. By measuring the velocity at those points, the flow rate can be approximated at inlets and outlets of the structures. The flow depths should be measured to the nearest tenth (10th) of a foot. Notes should be taken to verify the location, type of flow channel, flow velocity, typical dimensions, and the condition of the flow channel. The flow data should be taken in the same location each time.

11.0 ENGINEER'S ESTIMATE

This estimate reflects the bid items shown in the Contract Documents. The prices shown may vary depending upon the suppliers and the conditions encountered.

ESTIMATED CONSTRUCTION COSTS

NO	ITEM	UNIT	UNIT PRICE	AMOUNT	TOTAL PRICE
1	Mobilization/Demobilization	L. S.			$2,000.00
2	Live Stake Installation	Lft.	$8.00	130	$1,040.00
3	Post Revetment with Wire Fencing	Lft.	$24.00	1090	$26,160.00
4	Rip-Rap Slope	Lft.	$38.00	440	$16,720.00
5	Rip-Rap & Geocell Slope	Lft.	$36.00	580	$20,880.00
6	Vegetated Rock Gabion	Lft.	$112.00	60	$6,720.00
7	Live Cribwall	Lft.	$81.00	120	$9,720.00
8	Mulched Seeding	Sfs	$0.10	5200	$520.00
	TOTAL				$83,760.00

11.1 Estimated Construction Observation Cost

The estimated cost for a consulting engineering firm to provide construction observation services for the project, as it is described in this design report, is $9,000.00

11.2 Total Estimated Project Cost

The total estimated cost of this project, including construction and construction observation costs, is $92,760.00.

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